

The North Polar Spur: Detection of Nitrogen Enhancement with *Suzaku*

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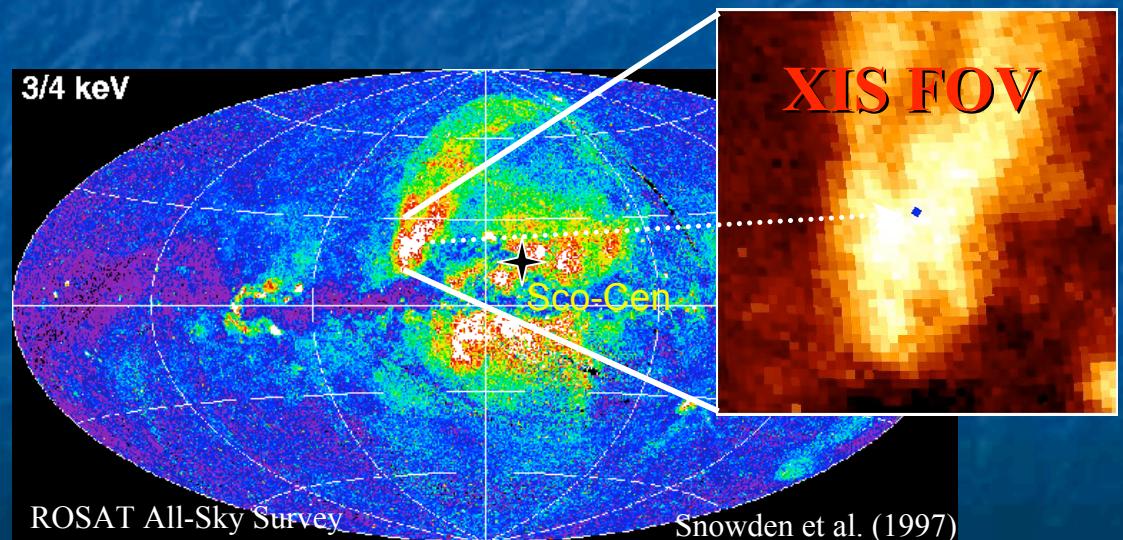
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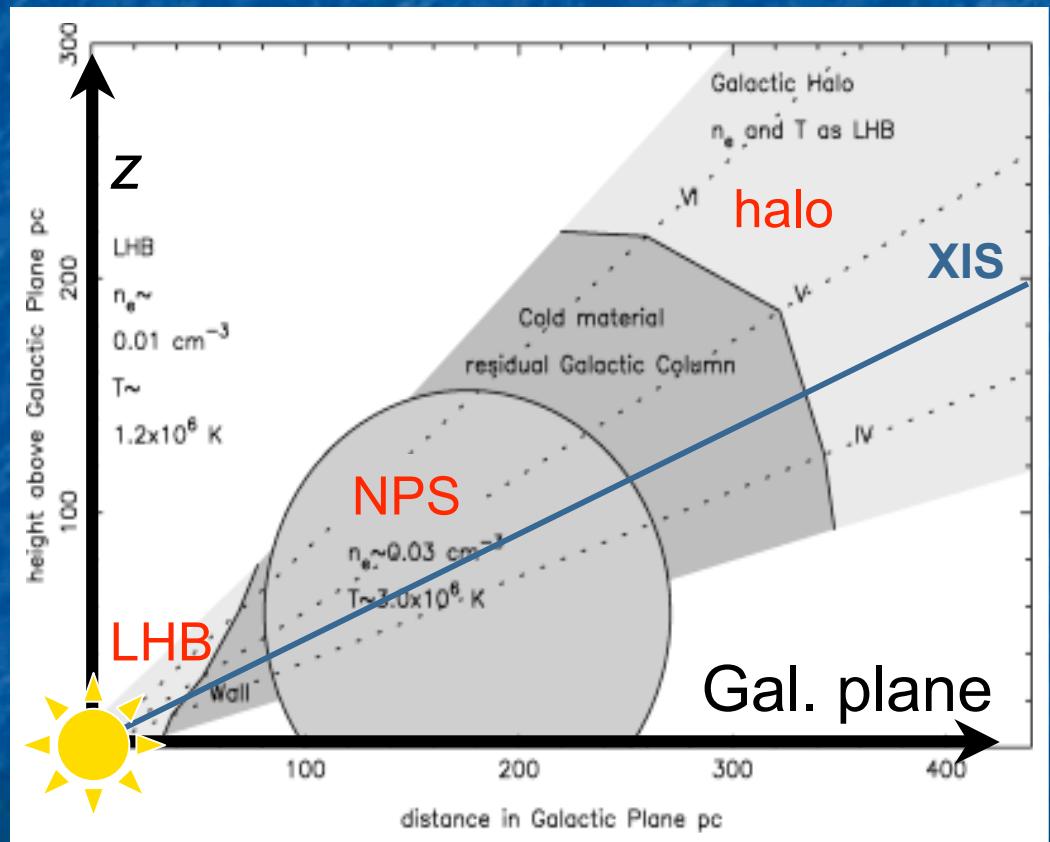
North Polar Spur (NPS)

- region of enhanced soft X-ray, radio emission (Loop 1)
 - nearby SNR?
 - Sco-Cen OB assoc. swept-out bubble? ~ 170 pc continuous stellar winds, SN
de Geuss 1992, Egger & Aschenbach 1995
- plasma conditions, chemical abundance constrain model
- measure NVII, CVI emission lines with *Suzaku/XIS*



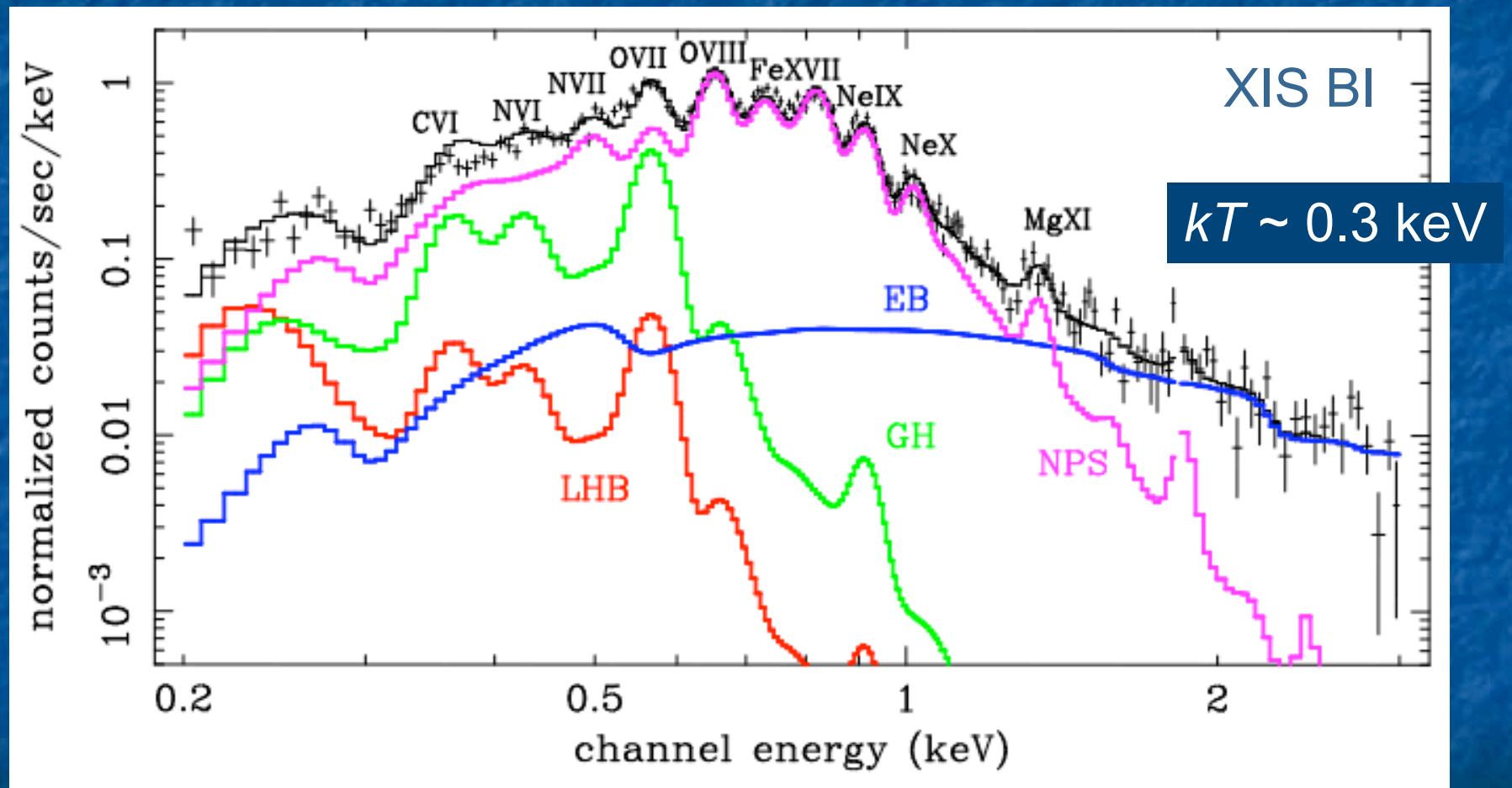
NPS Emission Model

- line of sight passes through several diffuse emission components
 - Local Hot Bubble
unabsorbed thermal
 $kT \sim 0.1 \text{ keV}$, solar
 - NPS
partly absorbed thermal
 $kT \sim ?$, abund $\sim ?$
 - Galactic halo
absorbed thermal
 $kT \sim 0.1 \text{ keV}$, solar
 - extragalactic background
absorbed power-law
 $\Gamma = 1.4$

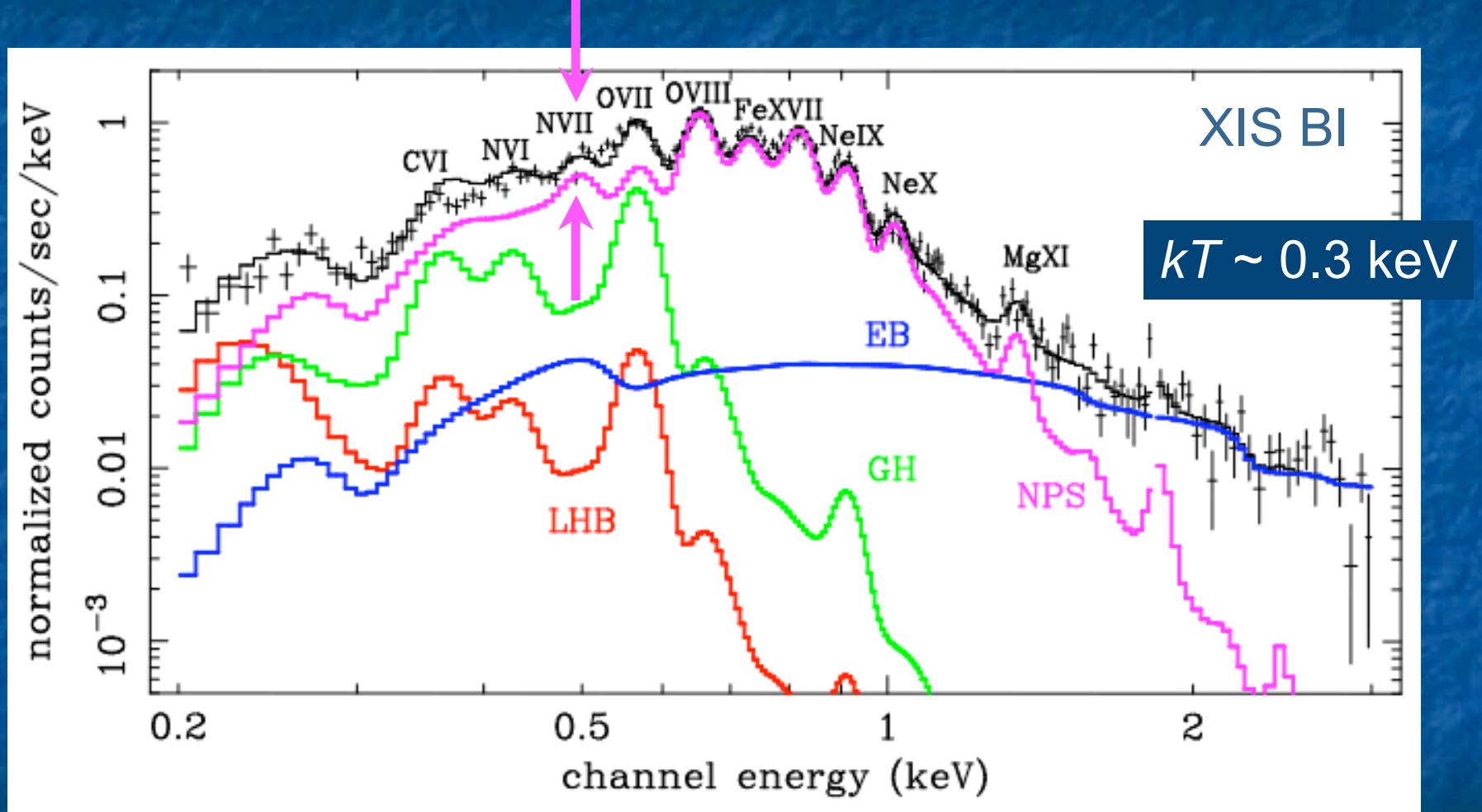


Willingale et al. 2003

NPS Suzaku Spectrum



NPS Emission from NVII !

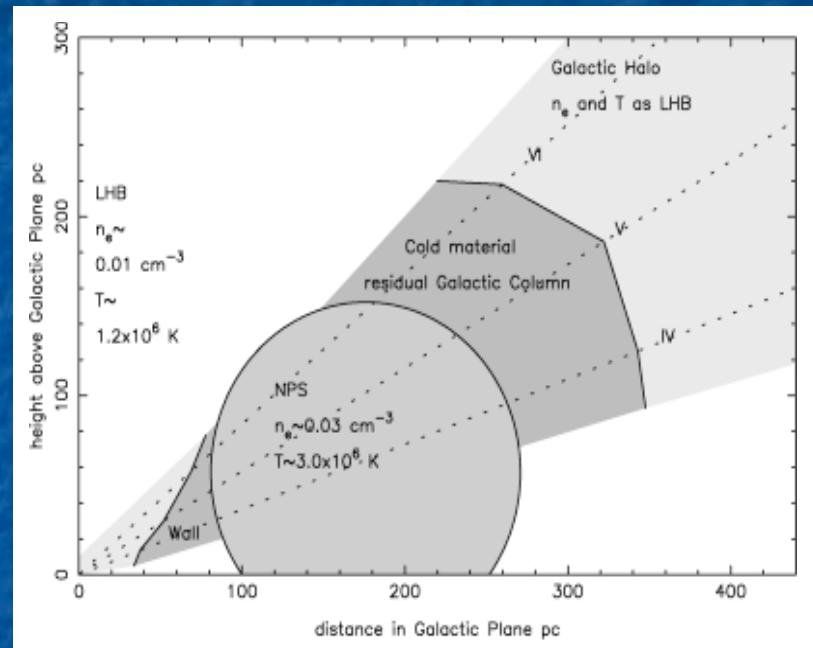


NPS Plasma Conditions

- $kT = 0.29 \pm 0.01$ keV
- $N_H > 4 \times 10^{20} \text{ cm}^{-2}$
 $> 70\%$ LOS value

RELATIVE ABUNDANCES

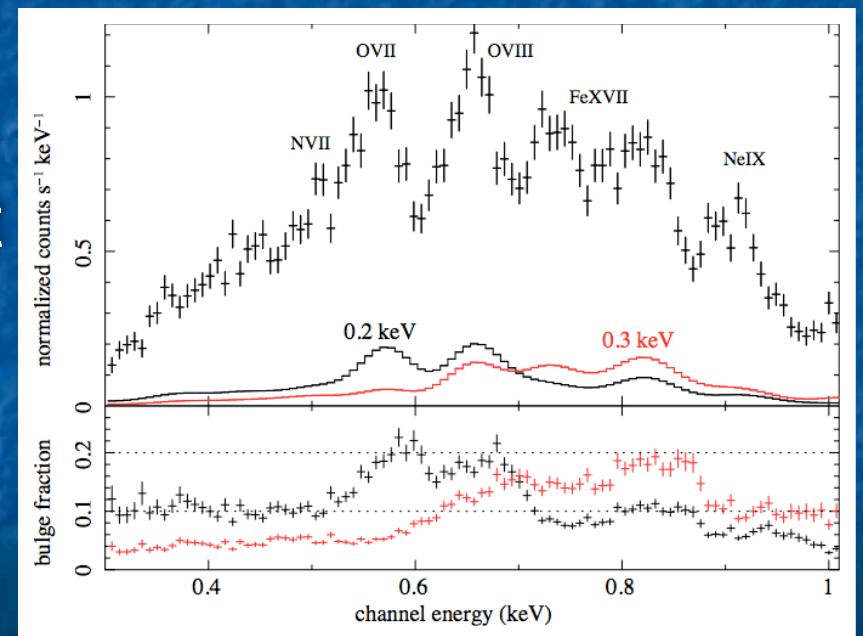
Ne/O	1.5 ± 0.3	solar
Mg/O	1.4 ± 0.3	solar
Fe/O	1.5 ± 0.2	solar
N/O	4.0 ± 0.4	solar



Nitrogen enhancement!
Is it *really* in the NPS?

Other Emission Sources

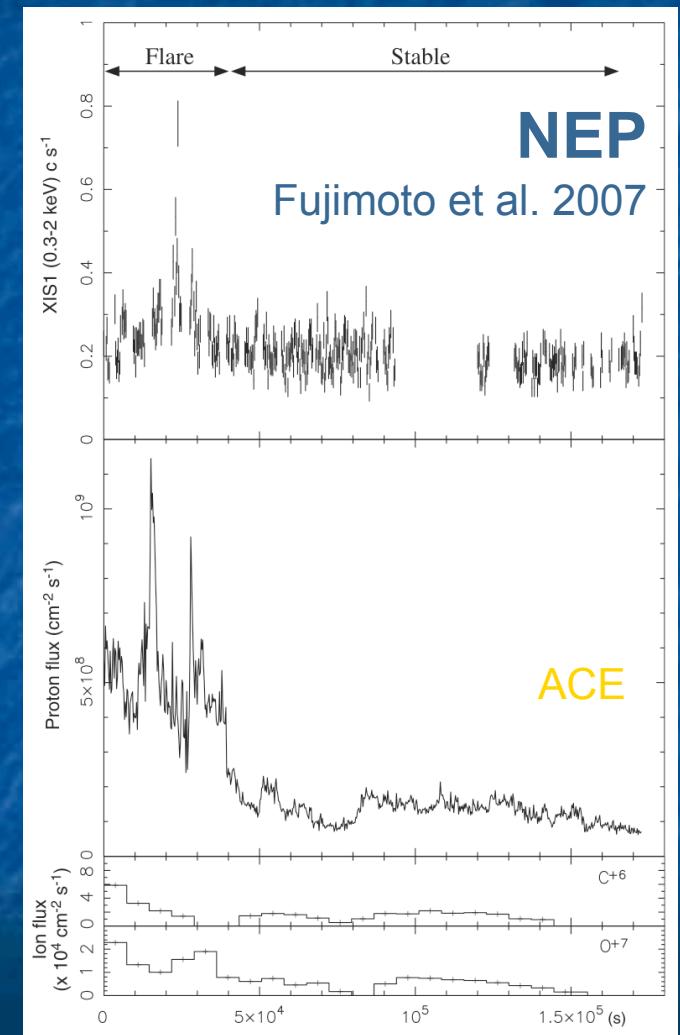
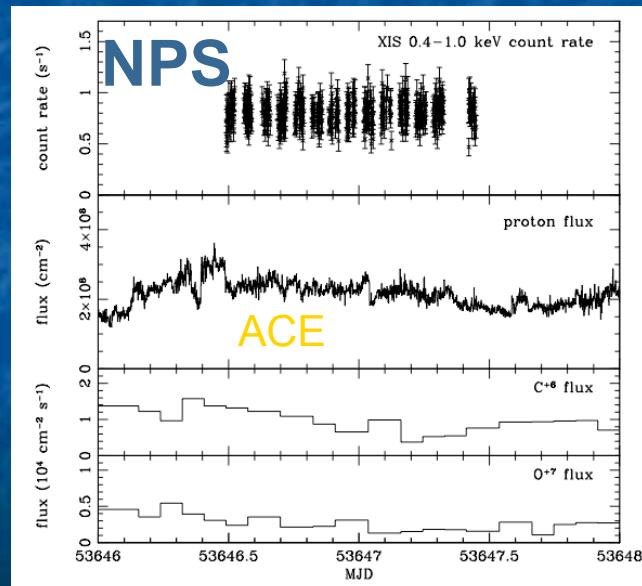
- two- kT galactic halo (0.1 & 0.2 keV)
Kuntz & Snowden 2000
 - S_X (GH) $\sim 20\%$ S_X (NPS)
- Galactic bulge: $kT \sim 0.2\text{-}0.3$ keV Snowden et al. 1997
 - polytrope model Almy et al. 2000
 - contributes $< 10\%$ to NVII
- other $kT \sim 0.2$ component
 - NVII / O line ratio still too large, assuming solar abundance and CIE



Solar Wind Charge Exchange?

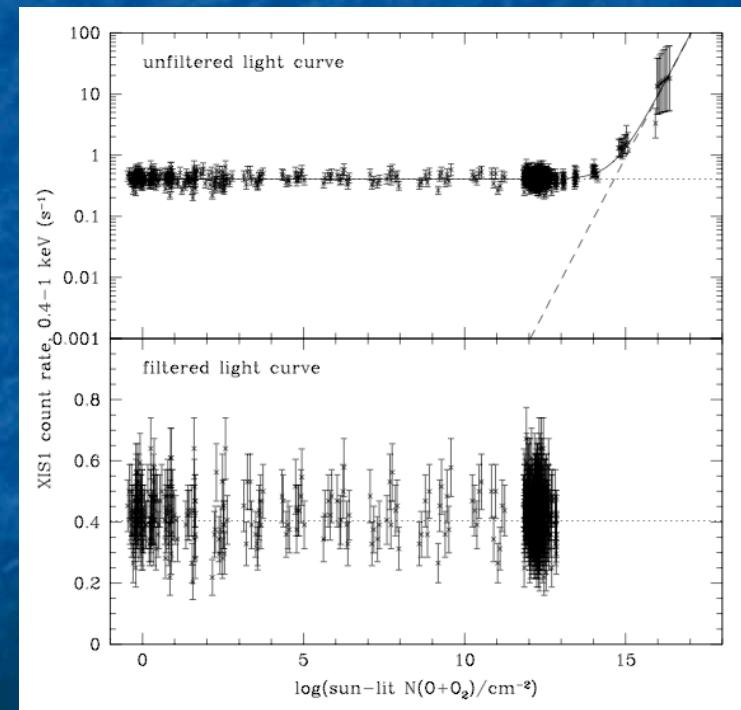
- geocoronal SWCX
→ C,O,Fe emission lines
- stable count rate, solar ion flux
- heliospheric?

Snowden et al. 1994, Fujimoto et al. 2007



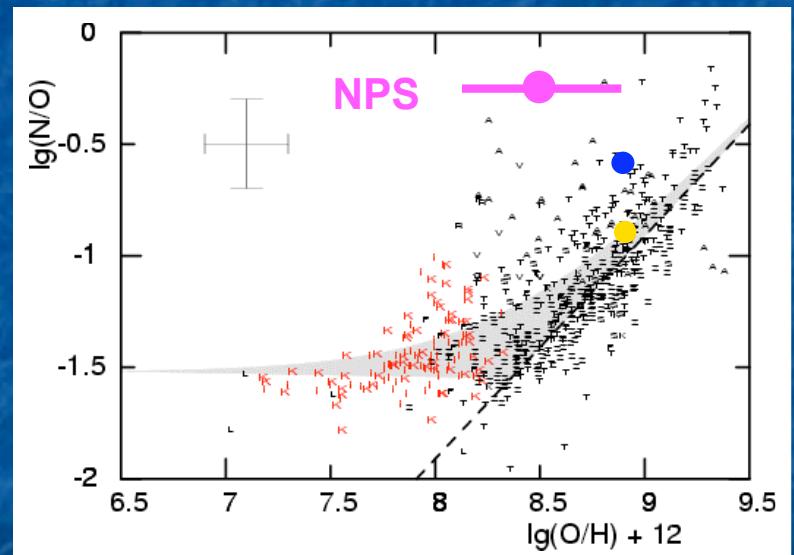
Scattered Solar X-rays?

- Thomson & fluorescent scattering of solar X-rays
→ O K α lines near 0.53 keV
 - flux \propto sun-lit column of O+O₂
 - screening →
 $N(\text{O+O}_2) < 5 \times 10^{12} \text{ cm}^{-2}$
 - $F(\text{solar}) < 10\% \text{ NVII}$
 $< 3\% \text{ OVII}$
- ✓ NVII is from NPS



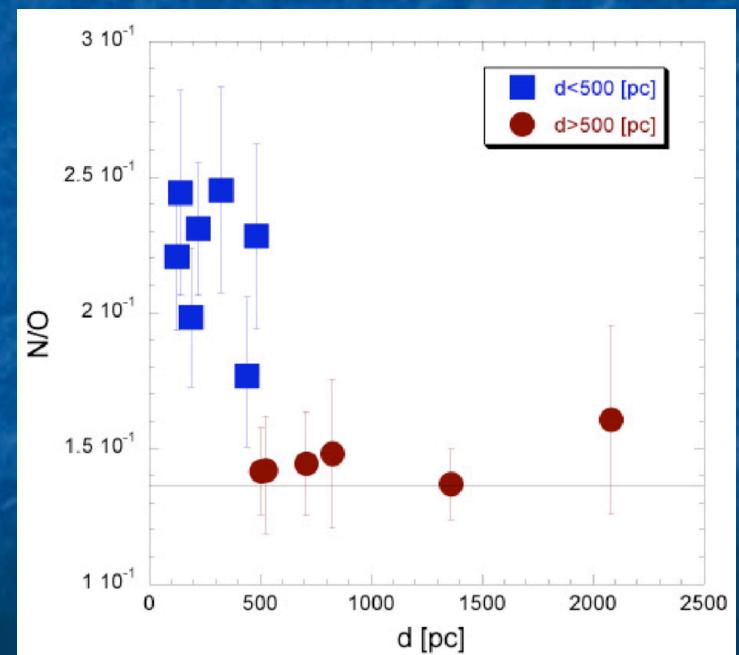
NPS - N Enrichment

- O primary production: massive stars, SN
- N primary+secondary production:
H shell burning in $4\text{-}8 M_{\odot}$ AGB stars
 - $^{14}\text{N} + \text{p} \rightarrow ^{15}\text{O} + \gamma$ limits CNO cycle
- enrichment source
 - Sco-Cen OB assoc
 $\sim 10^6\text{-}10^7$ yrs old
 - AGB stars form after $\sim 10^8$ yrs
- emitting material not from Sco-Cen: **AGB activity within Loop I? SN-heated ISM?**



Evidence for N Enrichment

- similar results from abs. studies
 $N/O > \text{solar}$ in local ISM ($d < 500$ pc)
Knauth et al. 2006
- enhanced recent AGB activity in solar neighborhood?
- large-scale mixing inhomogeneities?
- local infall of primordial material? Koppen and Hensler 2005
- $N/O \sim 4$ is very large



Summary

- *Suzaku* has good low-energy spectral resolution
- NPS plasma conditions
 - $kT \sim 0.3$ keV
 - $N_H > 4 \times 10^{20} \text{ cm}^{-2} = 70\%$ line of sight value
- NPS has over-abundance of N compared to O
 - enrichment of plasma by AGB activity; not Sco-Cen
 - similar result for ISM within 500 pc (absorption)
 - heating by recent SN?
 - AGB activity in Loop I bubble?